Large-scale transfer of 2D materials using the spalling process

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Nowadays two-dimensional (2D) materials are a very attractive development direction to microelectronic applications because of their electronic properties, revealed in early works [1]. However, the integration in real microelectronic devices is still a big challenge and needs further process developments before industrialization. As such, damage-free wafer-scale processes to manipulate 2D materials are researched worldwide [2]. Lately, a new way for 2D materials transfer was reported [3-4], usually called "spalling", which is one of dry transfer process using the strain induced by a metallic layer for delamination of 2D layers. In this work, we report the successful transfer of a few cm^2–wide-area of Graphene and MoS_2 by this spalling process. We compared the materials quality obtained after transfer by both this new method and by a commonly used wet transfer process. Physical and chemical defects have been studied by Raman spectroscopy, XPS, AFM and TEM. We also measured the electrical mobility and resistivity of the 2D materials after their transfer, providing a complete study of the impact of these transfer processes. Finally, we discuss on the scalability and the back-end CMOS compatibility for each method. The results suggest that the spalling is a promising method for large-scale transfer of 2D materials.

References

[1] K. S. Novoselov et al, Science 2016, vol 353, 6298
[2] M. Yi and Z. Shen, *J. Mater. Chem. A 2015*, 3, pp. 11700-11715
[3] J. Shim et al, Science 2018, vol 362, pp. 665-670
[4] J. Kim et al, Science 2013, vol 342, pp. 833-836

Figures

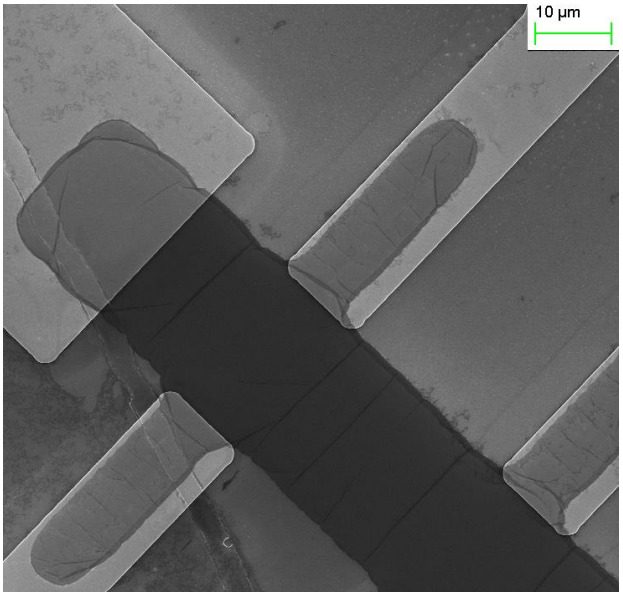

Figure 1: SEM image of 4 layers MoS_2 transferred on gold devices with the spalling process.

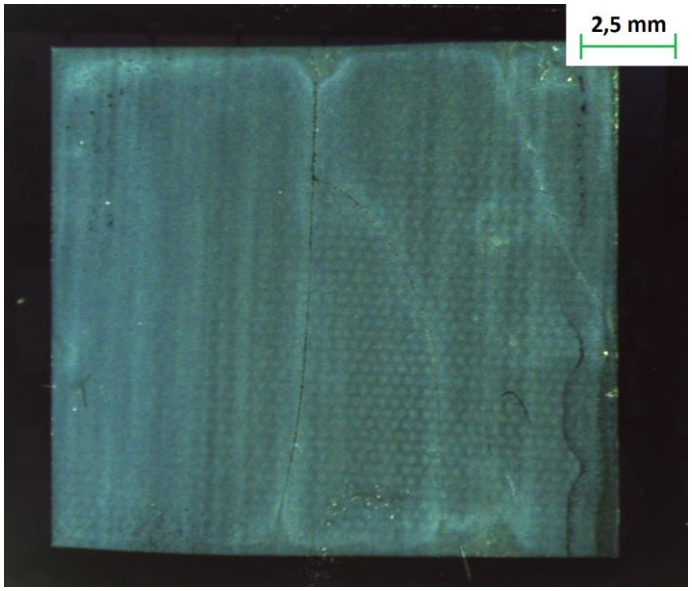

Figure 2: Optic image of Nickel + MoS_2 film transferred by spalling on squares SiO_2 cavities.